

## CLAIMS

What is claimed is:

- 1 1. A method of downconverting a signal and rejecting an image, comprising:
  - 2 providing a first, second, third, fourth and fifth signal, wherein the first signal
  - 3 has a frequency  $F$ , the second signal has a frequency  $F/N$ , the third signal has a
  - 4 frequency  $F/N$  and is phase shifted  $90^\circ$  with respect the second signal; the fourth
  - 5 signal has a frequency  $F/NM$ , and the fifth signal has a frequency  $F/NM$  and is phase
  - 6 shifted  $90^\circ$  from the fourth signal;
  - 7 mixing the first signal with an input signal to produce a first mixer output
  - 8 signal;
  - 9 splitting the first mixer output signal to produce a first splitter output signal and
  - 10 a second splitter output signal;
  - 11 mixing the first splitter output signal with the second signal to produce a
  - 12 second mixer output signal;
  - 13 mixing the second splitter output signal with the third signal to produce a third
  - 14 mixer output signal;
  - 15 mixing the second mixer output signal with the fourth signal to produce a
  - 16 fourth mixer output signal;
  - 17 mixing the third mixer output signal with the fifth signal to produce a fifth mixer
  - 18 output signal; and
  - 19 combining the fourth mixer output signal and the fifth mixer output signal to
  - 20 produce a combiner output signal.

1 2. The method of Claim 1, wherein mixing the first splitter output signal with the  
2 second signal to produce a second mixer output signal further comprises low-pass  
3 filtering.

1 3. The method of Claim 2, wherein mixing the second splitter output signal with  
2 the third signal to produce a third mixer output signal further comprises low-pass  
3 filtering.

1 4. The method of Claim 1, wherein N and M are integers greater than 1.

1 5. The method of Claim 4, wherein N and M are each multiples of 2.

1 6. The method of Claim 3, wherein providing the second, third, fourth, and fifth  
2 signals comprises digitally dividing the first signal.

1 7. The method of Claim 5, wherein N equals 2 and M equals 4.

1 8. The method of Claim 3, wherein F is a frequency in the range of 3.113 GHz to  
2 3.545 GHz.

1 9. The method of Claim 8, wherein the input signal has a frequency in the range  
2 of 5.15 GHz to 5.825 GHz.

1 10. The method of Claim 9, wherein the combiner output signal has a frequency  
2 of 90 MHz.

1 11. A method of upconverting a signal, and rejecting an image, comprising:

2 providing a first, second, third, fourth and fifth signal, wherein the first signal  
 3 has a frequency  $F$ , the second signal has a frequency  $F/N$ , the third signal has a  
 4 frequency  $F/N$  and is phase shifted  $90^\circ$  with respect the second signal; the fourth  
 5 signal has a frequency  $F/NM$ , and the fifth signal has a frequency  $F/NM$  and is phase  
 6 shifted  $90^\circ$  from the fourth signal;

7 splitting an input signal to produce a first splitter output signal a and second  
 8 splitter output signal;

9 mixing the first splitter output signal with the fifth signal to produce a first  
 10 mixer output signal;

11 mixing the second splitter output signal with the fourth signal to produce a  
 12 second mixer output signal;

13 high-pass filtering the first mixer output signal and the second mixer output  
 14 signal to produce, respectively a first filter output and a second filter output;

15 mixing the first filter output with the third signal to produce a third mixer output  
 16 signal;

17 mixing the second filter output with the second signal to produce a fourth  
 18 mixer output signal;

19 combining the third mixer output signal and the fourth mixer output signal to  
 20 produce combiner output signal; and

21 mixing the combiner output signal with the first signal to produce a transmitter  
 22 output signal.

1 12. The method of Claim 11, wherein  $N$  and  $M$  are integers greater than 1.

1 13. The method of Claim 12, wherein N and M are each multiples of 2.

1 14. The method of Claim 11, wherein providing the second, third, fourth, and fifth  
2 signals comprises digitally dividing the first signal.

1 15. The method of Claim 13, wherein N and M each equal 4.

1 16. A method of rejecting an image, comprising:

2 mixing an input signal with a local oscillator signal to produce a first  
3 intermediate frequency signal;

4 splitting the first intermediate frequency signal into a first part and a second  
5 part;

6 mixing the first part with a first clock signal to produce a first second-  
7 intermediate-frequency signal, and mixing the second part with a second clock  
8 signal, to produce a second second-intermediate-frequency signal;

9 filtering the first and second second-intermediate-frequency signals;

10 mixing the filtered first second-intermediate-frequency signal with a third clock  
11 signal to produce a first third-intermediate-frequency signal, and mixing the filtered  
12 second second-intermediate-frequency signal with a fourth clock signal to produce a  
13 second third-intermediate-frequency signal; and

14 combining the first third-intermediate-frequency signal with the second third-  
15 intermediate-frequency signal to produce an output signal;

16 wherein the first and second clock signals have a frequency that is less than  
17 that of the local oscillator by a factor of N, and the second clock signal is phase

18 shifted 90° from the first clock signal, the third and fourth clock signals have a  
19 frequency that is less than that of the local oscillator by a factor of NM, and the  
20 fourth clock signal is phase shifted 90° from the third clock signal, and N and M are  
21 integers greater than one.

1 17. The method of Claim 16, wherein N is a multiple of 2.

1 18. The method of Claim 16, wherein M is a multiple of 2.

1 19. The method of Claim 16, wherein N and M are each a multiple of 2.

1 20. The method of Claim 16, wherein the image is rejected in a receiver.

1 21. The method of Claim 16, wherein the image is rejected in a receiver, N and M  
2 are each a multiple of 2, and the filtering comprises low-pass filtering.

1 22. A method of rejecting an image, comprising:  
2 splitting a transmit baseband signal into a first part and a second part;  
3 mixing the first part with a first clock signal to produce a first second-  
4 intermediate-frequency signal, and mixing the second part with a second clock  
5 signal, to produce a second second-intermediate-frequency signal;  
6 high-pass filtering the first second-intermediate-frequency signal, and high-  
7 pass filtering the second second-intermediate-frequency signal;

8 mixing the high-pass filtered first second-intermediate-frequency signal with a  
9 third clock signal to produce a first third-intermediate-frequency signal, and mixing  
10 the high-pass filtered second second-intermediate-frequency signal with a fourth  
11 clock signal to produce a second third-intermediate-frequency signal;  
12 combining the first third-intermediate-frequency signal with the second third-  
13 intermediate-frequency signal to produce a combined signal; and  
14 mixing the combined signal with a local oscillator signal to produce a transmit  
15 output signal;  
16 wherein the first and second clock signals have a frequency that is less than  
17 that of the local oscillator by a factor of  $NM$ , and the second clock signal is phase  
18 shifted  $90^\circ$  from the first clock signal, the third and fourth clock signals have a  
19 frequency that is less than that of the local oscillator by a factor of  $N$ , and the fourth  
20 clock signal is phase shifted  $90^\circ$  from the third clock signal, and  $N$  and  $M$  are  
21 integers greater than one.

1 23. The method of Claim 22, wherein  $N$  and  $M$  are multiples of 2.

1 24. The method of claim 23, wherein the second part of the split transmit  
2 baseband signal is phase-shifted 180 degrees from the first part of the split transmit  
3 baseband signal.

1 25. An image rejection circuit, comprising:  
2 a local oscillator, a first divider coupled to the local oscillator, and a second  
3 divider coupled to the first divider network;

4 a first mixer having a first and second input terminals, and an output terminal;  
5 a first splitter having an input terminal coupled to the output terminal of the  
6 first mixer, and having a first and a second splitter output terminal;  
7 a second mixer having a first input terminal coupled to the first output terminal  
8 of the first splitter, a second input terminal coupled to an in-phase output terminal of  
9 the first divider, and having an output terminal;  
10 a third mixer having a first input terminal coupled to the second output  
11 terminal of the first splitter, a second input terminal coupled to a quadrature-phase  
12 output terminal of the first divider, and having an output terminal;  
13 a first filter coupled to the second mixer output terminal, and a second filter  
14 coupled to the third mixer output terminal;  
15 a fourth mixer having a first input terminal coupled to the first filter, a second  
16 input terminal coupled to an in-phase output terminal of the second divider, and  
17 having an output terminal;  
18 a fifth mixer having a first input terminal coupled to the second filter, a second  
19 input terminal coupled to a quadrature-phase output terminal of the second divider,  
20 and having an output terminal; and  
21 a combiner having a first input terminal coupled to the output terminal of the  
22 fourth mixer, a second input terminal coupled to the output terminal of the fifth mixer,  
23 and having an output terminal.

1 26. The circuit of Claim 25, wherein the in-phase and quadrature-phase output  
2 terminals of the first divider are adapted to provide signals that are phase shifted 90°  
3 from each other.

1 27. The circuit of Claim 26, wherein the in-phase and quadrature-phase output  
2 terminals of the first divider are adapted to provide signals that are the same  
3 frequency as each other, and that frequency is less than that of the local oscillator by  
4 a first factor which is a multiple of 2.

1 28. The circuit of Claim 27, wherein the in-phase and quadrature-phase output  
2 terminals of the second divider are adapted to provide signals that are the same  
3 frequency as each other, and that frequency is less than that of the local oscillator by  
4 a second factor which is a multiple of 2.

1 29. The circuit of Claim 28, wherein the second factor is greater than the first  
2 factor.

1 30. The circuit of Claim 25, wherein the first filter and the second filter are each  
2 low-pass filters.

1 31. The circuit of Claim 25, wherein the first input terminal of the first mixer is  
2 coupled to an input signal source.

1 32. The circuit of Claim 31, wherein the second input terminal of the first mixer is  
2 coupled to the local oscillator.

1 33. An image rejection circuit, comprising:  
2 a local oscillator, a first divider coupled to the local oscillator, and a second  
3 divider coupled to the first divider;



4 a first splitter having an input terminal coupled to an input signal source, a first  
5 output terminal and a second output terminal;

6 a first mixer having a first input terminal coupled to the first output terminal of  
7 the first splitter, a second input terminal coupled to a second output terminal of the  
8 second divider, and an output terminal;

9 a first high-pass filter coupled to the output terminal of the first mixer;

10 a second mixer having a first input terminal coupled to the second output  
11 terminal of the first splitter, a second input terminal coupled to a first output terminal  
12 of the second divider, and an output terminal;

13 a second high-pass filter coupled to the output terminal of the second mixer;

14 a third mixer having a first input terminal coupled to first high-pass filter, a  
15 second input terminal coupled to a second output terminal of the first divider, and an  
16 output terminal;

17 a fourth mixer having a first input terminal coupled to the second filter, a  
18 second input terminal coupled to a first output terminal of the first divider, and having  
19 an output terminal;

20 a combiner having a first input terminal coupled to the output terminal of the  
21 third mixer, a second input terminal coupled to the output terminal of the fourth  
22 mixer, and an output terminal; and

23 a fifth mixer having a first input terminal coupled to the output terminal of the  
24 combiner, a second input terminal coupled to an output of the local oscillator, and  
25 having an output terminal.

1 34. The circuit of Claim 33, wherein the input terminal of the first splitter is  
2 coupled to an input signal source.

1004346-010902  
205070-942400F

1 35. The circuit of Claim 33, wherein the input terminal of the first splitter is  
2 coupled to a transmit baseband signal source.

1 36. The circuit of Claim 33, wherein the first divider and the second divider each  
2 divide by factor wherein the factor is a multiple of 2.

1 37. An image rejection circuit, comprising:

2 a local oscillator, a first divider coupled to the local oscillator, and a second  
3 divider coupled to the local oscillator;

4 a first mixer having two input terminals and an output terminal;

5 a first splitter having an input terminal coupled to the output terminal of the  
6 first mixer, and having a first and a second splitter output terminal;

7 a second mixer having a first input terminal coupled to the first output terminal  
8 of the first splitter, a second input terminal coupled to an in-phase output terminal of  
9 the first divider, and having an output terminal;

10 a third mixer having a first input terminal coupled to the second output  
11 terminal of the first splitter, a second input terminal coupled to a quadrature-phase  
12 output terminal of first divider, and having an output terminal;

13 a first filter coupled to the second mixer output terminal, and a second filter  
14 coupled to the third mixer output terminal;

15 a fourth mixer having a first input terminal coupled to the first filter, a second  
16 input terminal coupled to an in-phase output terminal of the second divider, and  
17 having an output terminal;

18 a fifth mixer having a first input terminal coupled to the second filter, a second  
19 input terminal coupled to a quadrature-phase output terminal of the second divider,  
20 and having an output terminal; and

21 a combiner having a first input terminal coupled to the output terminal of the  
22 fourth mixer, a second input terminal coupled to the output terminal of the fifth mixer,  
23 and having an output terminal.

1 38. The circuit of Claim 37, wherein the first divider and the second divider each  
2 divide by factor wherein the factor is a multiple of 2.

1 39. An image rejection circuit, comprising:

2 a local oscillator, a first divider coupled to the local oscillator, and a second  
3 divider coupled to the local oscillator;

4 a first splitter having an input terminal coupled to an input signal source, a first  
5 output terminal and a second output terminal;

6 a first mixer having a first input terminal coupled to the first output terminal of  
7 the first splitter, a second input terminal coupled to a second output terminal of the  
8 second divider, and an output terminal;

9 a first high-pass filter coupled to the output terminal of the first mixer;

10 a second mixer having a first input terminal coupled to the second output  
11 terminal of the first splitter, a second input terminal coupled to a first output terminal  
12 of the second divider, and an output terminal;

13 a second high-pass filter coupled to the output terminal of the second mixer;

14 a third mixer having a first input terminal coupled to first high-pass filter, a  
15 second input terminal coupled to a second output terminal of the first divider, and an  
16 output terminal;

17 a fourth mixer having a first input terminal coupled to the second filter, a  
18 second input terminal coupled to a first output terminal of the first divider, and having  
19 an output terminal;

20 a combiner having a first input terminal coupled to the output terminal of the  
21 third mixer, a second input terminal coupled to the output terminal of the fourth  
22 mixer, and an output terminal; and

23 a fifth mixer having a first input terminal coupled to the output terminal of the  
24 combiner, a second input terminal coupled to an output of the local oscillator, and  
25 having an output terminal.

1 40. The circuit of Claim 39, wherein the first divider and the second divider each  
2 divide by factor wherein the factor is a multiple of 2.

3